Docket No. 57810-072 PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re Application of	:	Customer Number: 20277
Makoto IZUMI, et al.	:	Confirmation Number: 3514
Serial No. 10/637,664	:	Group Art Unit: 2812
Filed: August 11, 2003	:	Examiner: W. Brewster

For: SOLID STATE IMAGE DEVICE AND MANUFACTURING METHOD THEREOF

TRANSMITTAL OF APPEAL BRIEF

Mail Stop Appeal Brief
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Submitted herewith in triplicate is Appellant(s) Appeal Brief in support of the Notice of Appeal filed February 28, 2005. Please charge the Appeal Brief fee of $500.00 to Deposit Account 500417.

To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account 500417 and please credit any excess fees to such deposit account.

Respectfully submitted,

MCDERMOTT, WILL & EMERY

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Date: March 24, 2005
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BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

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Application No.: 10/637,664	:	Tech Center Art Unit: 2812
Filed: August 11, 2003	:	Examiner: W. Brewster

For: SOLID STATE IMAGE DEVICE AND MANUFACTURING METHOD THEREOF

APPEAL BRIEF

Mail Stop Appeal Brief
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

This Appeal Brief is submitted in support of the Notice of Appeal filed on February 28, 2005, wherein Appellants appealed from the Examiner's final rejection of claims 1 through 12.

I. Real Party In Interest

The real party and interest is Sanyo Electric Co., Ltd.

II. RELATED APPEALS AND INTERFERENCES

Appellants are unaware of any related Appeal or Interference.

III. STATUS OF CLAIMS

Claims 1 through 21 are pending in this application, of which claims 13 through 21 stand withdrawn from consideration pursuant to the provisions of 37 C.F.R. §1.142(b). Accordingly, claims 1 through 12 have been finally rejected. It is from the final rejection of claims 1 through 12 that this Appeal is taken.

IV. STATUS OF AMENDMENTS

No Amendment has been filed subsequent to the issuance of the Final Office Action dated December 15, 2005.[1]

V. SUMMARY OF THE CLAIM SUBJECT MATTER

Independent claim 1, the only independent claim on appeal, is directed to a solid state image device, and can be appreciated from Fig. 2. The claimed solid state image device comprises an optical lens (4), a solid state image sensor having a microlens (11, 12) and a resin layer 5 between the optical lens and the microlens.

Based upon the discussion of Fig. 2 in the written description of the specification, commencing at page 18, line 18, one having ordinary skill in the art would have understood that an optical lens is a lens that condenses reflected light from an object and provides the condensed light to a solid state image device from the outside; whereas, a microlens condenses light inside the solid state image device.

[1] A final Office Action was issued on December 1, 2004. However, the Examiner was advised that the argument advanced in the responsive Amendment submitted November 4, 2004 was misinterpreted. Consequently, the Final Office Action dated December 15, 2004 was issued superseding the December 1, 2004 Final Office Action.

VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

1. Claims 1 through 9 were rejected under 35 U.S.C. §103 for obviousness predicated upon JP10/229180 (Kuroiwa)[2] in view of DiLoreto et al.;

2. Claims 10 and 11 were rejected under 35 U.S.C. §103 for obviousness predicated upon Kuroiwa in view of DiLoreto and Needham;

3. Claim 12 was rejected under 35 U.S.C. §103 for obviousness predicated upon Kuroiwa in view of DiLoreto, Needham and Wolff.

VII. ARGUMENT

For the convenience of the Honorable Board of Patent Appeals and Interferences (the Board), Appellants separately argue the patentability of independent claim 1, allowing claims 2 through 12 to stand or fall with independent claim 1.

Pivotal Issue

The pivotal issue in this appeal is whether the Examiner factually established that a microlens is the same as an optical lens. They are not. Hence, the Examiner committed clear factual error.

The Examiner's Position

As previously discussed, independent claim 1 is directed to a solid state image device comprising an optical lens, a solid state image sensor which includes a microlens, and a resin layer formed between the optical lens and the microlens. No such structure is disclosed or suggested by either of the applied references. The Examiner says but does not factually establish otherwise.

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[2] The Examiner referred to this reference by the inventor's first name, Atsushi, rather than his last name Kuroiwa. Appellants will refer to this reference by the inventor's last name, i.e., Kuroiwa.

In the statement of the rejection, the Examiner referred to Fig. 2 of Kuroiwa asserting the disclosure of a solid state image device comprising element 24, **erroneous** dubbed an optical lens, image sensor 16, 17 and microlens 22. The Examiner admitted that Kuroiwa does not disclose a resin layer between lens 24 and lens 22. The Examiner turns to DiLoreto et al. and concludes that one having ordinary skill in the art would have been motivated to modify Kuroiwa's device by inserting the filter disclosed by DiLoreto et al. a portion of which contains a resin film 62.

In the responsive Amendment submitted November 4, 2004, Appellants strenuously argued that the Examiner's rejections were predicated upon an **inaccurate** factual determination as to the teachings of Kuroiwa. Specifically, the Examiner asserted that element 24 in the Fig. 2 device of Kuroiwa is an optical lens. This is factually **wrong**, because the element denoted by reference character 24 in Kuroiwa's Fig. 2 device is not an optical lens but a **microlens**. In fact, Kuroiwa says it is a microlens, as should be apparent from the English language Abstract provided by the Examiner. This the Examiner does not dispute. But the Examiner says an optical lens is microlens. But saying that element 24 is a optical lens does make it so.

In an attempt to support the unsupportable position that there is no difference between an optical lens and a microlens in the context of the present invention, the Examiner cited a new reference to Suzuki et al. on page 6 of the December 15, 2004 final Office Action, but did not see fit to include that reference in the statements of the rejections. The Examiner relies upon one sentence wherein Suzuki et al. spell a microlens two different ways, one way "microlens" and another "micro optical lens". The Examiner is clearly factually wrong.

Appellants' Position

Appellants submit that Kuroiwa must be taken at face value in disclosing a device containing a first microlens 22 and a second microlens 24. Kuroiwa does not disclose a solid state image device containing an optical lens, a solid state image sensing including a microlens, or a resin layer formed therebetween.

The Examiner's attempt to rely upon Suzuki et al. is clearly misplaced, because Suzuki et al. merely disclose two different ways to spell a microlens. The Examiner's reliance upon ways to spell objects is not legally viable and certainly not dispositive of the legal issue of claim interpretation.

In this respect, Appellants submit that one having ordinary skill in the art would have understood from the present application that a microlens condenses light inside a solid state image device. Specifically, a microlens condenses incident light on photoreceptive parts (7). Appellants invite attention to page 21 of the written description of the specification, line 24 through page 22 thereof, line 1, wherein the following evulgation appears:

> Thus, the photoreceptive parts 7 can condense the light incident upon the SiN films 11 and 12 serving as microlens from the resin layer 5, ...

On the other hand, an optical lens condenses light reflected from an object and provides the condensed light to the solid state image device from the **outside**, as would have been understood by one having ordinary skill in the art.

Appellants submit that, as a factual matter, there is an art-recognized difference between a microlens and an optical lens, particularly in the context of the present invention, which would have been understood by one having ordinary skill in the art. Therefore, Appellants solicit the Honorable Board to take judicial notice of the art-recognized difference between a microlens on the one hand and an optical lens on the other hand. For the convenience of the Honorable Board, Appellants have

appended hereto as Exhibit A a copy of an Information Disclosure Statement filed on March 17, 2005 bringing to the attention of the Examiner the reference to Omae et al., JP06-53451. At page 2 of Omae et al., paragraph [0004], the following disclosure appears:

> When light from an object is condensed by an optical lens for forming an object image on the solid state image device and thereafter the light is irradiated to the solid state image device, the light is condensed by the microlenses 19, projected on the photodiodes 12 and converted to signal charged to be stored.

It should, therefore, be apparent as a factual matter that a microlens condenses light inside a solid state image device and guides the light to the photoreceptive parts of the pixal (photodiodes). In contradistinction thereto, an optical lens condenses light reflected from an object. This is how one having ordinary skill in the art would have interpreted the claims as well as Kuroiwa. The Examiner can not change the facts by relying on different ways to spell a microlens without addressing the art-recognized difference between a microlens and an optical lens.

Appellants, therefore, submit that the Examiner committed clear factual error by characterizing element 24 in Fig. 2 of Kuroiwa as an optical lens, because it is just what Kuroiwa say it is-a microlens. A microlens is not an optical lens. The secondary reference to DiLoreto et al. does not cure the argued deficiency of Kuroiwa. Accordingly, even if the applied references are combined as suggested by the Examiner, and Appellants do not agree that the requisite fact-based motivation has been established, the claimed invention would not result. *Uniroyal, Inc. v. Rudkin-Wiley Corp., 837 F.2d 1044, 5 USPQ2d 1434 (Fed. Cir. 1988).*

As previously discussed, claims 2 through 12 stand or fall with independent claim 1. Appellants would submit that neither Needham nor Wolff cure the previously argued deficiencies of Kuroiwa. Based upon the foregoing, Appellants submit that the Examiner's rejections under 35 U.S.C. §103 are not factually or legally viable.

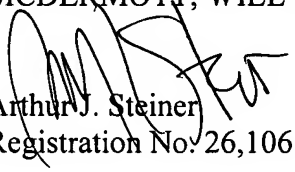
VIII. PRAYER FOR RELIEF

As previously argued, the Examiners rejections under 35 U.S.C. §103 are not factually or legally viable. Appellants, therefore, solicit the Honorable Board to reverse each of the Examiner's rejections under 35 U.S.C. §103.

To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account 500417 and please credit any excess fees to such deposit account.

Respectfully submitted,

MCDERMOTT, WILL & EMERY



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Date: March 24, 2005

CLAIMS

1. A solid state image device comprising:

an optical lens;

a solid state image sensor including a microlens; and

a resin layer formed between said optical lens and said microlens of said solid state image sensor.

2. The solid state image device according to claim 1, wherein

said optical lens and said microlens of said solid state image sensor are integrally formed through said resin layer.

3. The solid state image device according to claim 1, wherein

said microlens of said solid state image sensor has a refractive index larger than the refractive index of said resin layer.

4. The solid state image device according to claim 1, wherein

said microlens of said solid state image sensor includes:

a first film having an upwardly projecting shape, and

a second film, formed on said first film, having an upwardly projecting shape reflecting said upwardly projecting shape of said first film.

5. The solid state image device according to claim 4, wherein

said first film and said second film are made of materials having the same refractive index.

6. The solid state image device according to claim 5, wherein

said first film and said second film are formed by SiN films.

7. The solid state image device according to claim 4, wherein

said first film is formed with a plurality of said upwardly projecting shapes at prescribed intervals, and

said second film is formed with a plurality of said upwardly projecting shapes to fill up gaps of said first film.

8. The solid state image device according to claim 7, wherein

each adjacent pair of said upwardly projecting shapes of said second film are connected with each other to include no substantially flat region on the boundary therebetween.

9. The solid state image device according to claim 7, wherein

the boundary between each adjacent pair of said upwardly projecting shapes of said second film has a thickness of at least 10 nm.

10. The solid state image device according to claim 1, further comprising a recessed third film formed on said solid state image sensor, wherein

said microlens of said solid state image sensor includes a fourth film, embedded in the recessed portion of said third film, exhibiting a larger refractive index than said third film and having a downwardly projecting shape.

11. The solid state image device according to claim 10, wherein

said fourth film is formed by an SiN film.

12. The solid state image device according to claim 11, wherein

said third film is formed by an SOG film.

Docket No.: 057810-0072 **PATENT**

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of	:	Customer Number: 20277
Makoto IZUMI, et al.	:	Confirmation Number: 3514
Application No.: 10/637,664	:	Group Art Unit: 2812
Filed: August 11, 2003	:	Examiner: William M. Brewster

For: SOLID STATE IMAGE DEVICE AND MANUFACTURING METHOD THEREOF

INFORMATION DISCLOSURE STATEMENT

Mail Stop
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

This Information Disclosure Statement is being filed more than three months after the U.S. filing date and after the mailing date of a Final Rejection or Notice of Allowance, but before payment of the Issue Fee.

REQUEST TO CONSIDER REFERENCES AFTER CLOSE OF PROSECUTION AND BEFORE PAYMENT OF ISSUE FEE

The undersigned hereby requests consideration and entry of this Information Disclosure Statement and accompanying references under 37 CFR 1.97(d).

Please charge the processing fee under 1.17(p) of $180.00 to Deposit Account 500417.

CERTIFICATION PARAGRAPH

The undersigned certifies that no item of information in this Information Disclosure Statement was cited in a communication from a foreign patent office in a counterpart foreign application or, to my knowledge after making reasonable inquiry, was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of this Information Disclosure Statement. 37 CFR 1.97(e)(2).

Please note that the reference listed on the PTO Form 1449, Japanese Patent Laid-Open JP 06-53451, has not been cited in an Office Action or Search Report. The applicant searched references relevant to the present invention, and as a result, then became aware of the above-described reference on February 16, 2005. Accordingly, there is no document indicating the exact date that the applicant became aware of the above-described reference.

Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account 500417 and please credit any excess fees to such deposit account.

Respectfully submitted,

McDERMOTT WILL & EMERY LLP

Arthur J. Steiner
Registration No. 26,106

Please recognize our Customer No. 20277 as our correspondence address.

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Date: March 17, 2005

INFORMATION DISCLOSURE CITATION IN AN APPLICATION

(PTO-1449)

ATTY. DOCKET NO.	SERIAL NO.
057810-0072	**10/637,664**
APPLICANT: **Makoto IZUMI, et al.**	
FILING DATE: **August 11, 2003**	GROUP: **2812**

U.S. PATENT DOCUMENTS

EXAMINER'S INITIALS	CITE NO.	Document Number Number-Kind Code2 (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		US			
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FOREIGN PATENT DOCUMENTS

EXAMINER'S INITIALS	CITE NO.	Foreign Patent Document Country Codes3 –Number 4 –Kind Codes (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines Where Relevant Figures Appear	Translation Yes	Translation No
		JP 6-53451	**02/25/1994**	**MATSUSHITA ELECTRON CORP.**		**JAPAN (w/English Abstract)**	

OTHER ART (Including Author, Title, Date, Pertinent Pages, Etc.)

EXAMINER'S INITIALS	CITE NO.	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	

EXAMINER	DATE CONSIDERED

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

1 Applicant's unique citation designation number (optional). 2 Applicant is to place a check mark here if English language Translation is attached.

PATENT ABSTRACTS OF JAPAN

(11)Publication number : 06-053451
(43)Date of publication of application : 25.02.1994

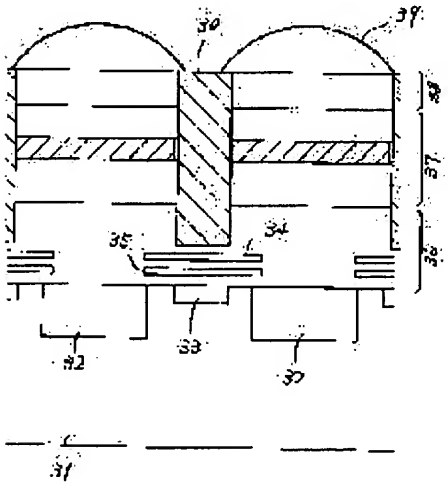
(51)Int.Cl. H01L 27/14
H01L 21/76
H04N 1/028
H04N 5/335

(21)Application number : 04-203307
(22)Date of filing : 30.07.1992

(71)Applicant : MATSUSHITA ELECTRON CORP
(72)Inventor : OMAE MASANORI
MORI YOSHIKIMI

(54) SOLID STATE IMAGE SENSOR

(57)Abstract:
PURPOSE: To provide a highly sensitive solid state image sensor by introducing the light from an object efficiently to a photodiode.
CONSTITUTION: An intermediate layer comprising planarization layers 36, 38 and a color separation layer 37, sandwiched by photodiodes 32 arranged one-dimensionally or two-dimensionally and microlenses 39 arranged oppositely thereto, is isolated through an isolation layer 30 at the border part of the photodiode 32, wherein the isolation layer 30 is composed of a material having refractive index lower than the intermediate layer.



LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

Japanese Patent Office
Patent Laying-Open Gazette

Patent Laying-Open No. 6-53451
Date of Laying-Open: February 25, 1994
International Class(es): H01L 27/14
H01L 21/76
H04N 1/028
5/335

Title of the Invention: Solid State Image Device

Patent Appln. No. 4-203307
Filing Date: July 30, 1992
Inventor(s): Masanori Omae
Yoshikimi Mori
Applicant(s): Matsushita Electron Corp

(transliterated, therefore the spelling might be incorrect)

---- not translated ----

[0003] The following is a description relating to a conventional solid state image device. Fig. 3 is a sectional view of a conventional solid state image device. In Fig. 3, reference number 11 indicates an Si substrate, reference number 12 indicate photodiodes formed on the Si substrate 11 for converting light to signal charges,

reference number 13 indicates a transfer part formed on the Si substrate 11 for transferring charges converted by the photodiodes 12, reference number 14 indicates an aluminum shielding film shielding the transfer part 13, reference number 15 indicates a gate electrode of the transfer part 13 formed under the aluminum shielding film 14, reference number 16 indicates a planarization layer to form a color isolation filter layer formed on the Si substrate 11, reference number 17 indicates a color isolation filter layer formed on the planarization layer 16, reference number 18 indicates a planarization layer to form microlenses formed on the color isolation filter layer 17, reference number 19 indicate microlenses formed on the planarization layer 18, and the photodiodes 12 indicate arranged one-dimensionally or two-dimensionally.

[0004] When light from an object is condensed by an optical lens for forming an object image on the solid state image device and thereafter the light is irradiated to the solid state image device, the light is condensed by the microlenses 19, projected on the photodiodes 12 and converted to signal charges to be stored. Signal charges stored for a certain period are read into the transfer part 13, and after being transferred in the transfer part 13, signal charges are output.

---- not translated ----

(19)日本国特許庁（ＪＰ）　(12)公開特許公報（Ａ）　(11)特許出願公開番号

特開平6－53451

(43)公開日　平成６年(1994)２月25日

(51)Int.Cl.⁵		識別記号	庁内整理番号	ＦＩ	技術表示箇所
Ｈ０１Ｌ	27/14				
	21/76		L 9169－4M		
Ｈ０４Ｎ	1/028		Z 9070－5C		
	5/335		V		
			7210－4M	Ｈ０１Ｌ 27/14	

審査請求　未請求　請求項の数１(全　４　頁)

(21)出願番号　特願平4－203307

(22)出願日　平成４年(1992)７月30日

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(54)【発明の名称】　固体撮像装置

(57)【要約】
【目的】被写体からの光を効率よくフォトダイオードに導くことにより、感度の高い固体撮像装置を提供する。
【構成】一次元あるいは二次元状に配列されたフォトダイオード３２とこのフォトダイオード３２に対向して配設されたマイクロレンズ３９の間にはさまれる平坦化層３６，３８、色分離フィルタ層３７より成る中間層を隣りあうフォトダイオード３２の境界部分で分離層３０により分離し、この分離層３０を中間層を構成する物質より小さな屈折率の物質により構成する。

【特許請求の範囲】

【請求項1】 一次元あるいは二次元状に配列されたフォトダイオードおよび前記フォトダイオードに対向して配設されたマイクロレンズにはさまれる中間層が隣りあうフォトダイオードの境界部分で前記中間層を構成する物質より小さな屈折率の物質により分離されていることを特徴とする固体撮像装置。

【発明の詳細な説明】

【０００１】

【産業上の利用説明】本発明は、固体撮像装置に関するものである。

【０００２】

【従来の技術】近年固体撮像装置はビデオカメラの発展にともない、小型化、高画素化、高感度化が進められている。

【０００３】以下、従来の固体撮像装置について説明する。図3は従来の固体撮像装置の断面図を示す。図3において、１１はシリコン基板、１２はシリコン基板１１上に形成されて光を信号電荷に変換するフォトダイオード、１３は同じくシリコン基板１１上に形成されてフォトダイオード１２により変換された電荷を転送する転送部、１４は転送部１３を遮蔽するアルミ遮光膜、１５はアルミ遮光膜１４の下側に形成された転送部１３のゲート電極、１６はシリコン基板１１上に形成された色分離フィルタ層形成のための平坦化層、１７は平坦化層１６上に形成された色分離フィルタ層、１８は色分離フィルタ層１７上に形成されたマイクロレンズ形成のための平坦化層、１９は平坦化層１８上に形成されたマイクロレンズであり、フォトダイオード１２は一次元あるいは二次元状に配列されている。

【０００４】被写体からの光を光学レンズで集光し、固体撮像装置上に結像させ、固体撮像装置に光を当てると、その光はマイクロレンズ１９により集光され、フォトダイオード１２に入射され、信号電荷に変換、蓄積される。一定期間蓄積された信号電荷は、転送部１３に読み出され、転送部１３を転送された後、外部に出力される。

【０００５】図4は従来の固体撮像装置のフォトダイオードへの光入射の模式図を示す。被写体のある点からの光は光学レンズを通り、固体撮像装置の一点に集光される。１つのフォトダイオードに着目した場合、図4のように光路２１から光路２２の範囲の光がマイクロレンズ１９により光路を曲げられ、フォトダイオード１２に入射されることになる。

【０００６】

【発明が解決しようとする課題】しかしながら上記の構成では、光学レンズの絞り値が大きくなるにしたがい、光の通過する範囲が広がり、マイクロレンズへの光入射角度が大きくなってしまう。そのため、光学レンズの周辺部を通過した光はマイクロレンズ１９でフォトダイオード１２に集光することができず、被写体の明るさの低下率以上に固体撮像装置の感度が低下してしまう欠点があった。

【０００７】本発明は上記問題を解決するもので、低照度での感度低下を抑えることができる固体撮像装置を提供することを目的とするものである。

【０００８】

【課題を解決するための手段】上記課題を解決するために本発明の固体撮像装置は、一次元あるいは二次元状に配列されたフォトダイオードおよび前記フォトダイオードに対向して配設されたマイクロレンズにはさまれる中間層が隣りあうフォトダイオードの境界部分で前記中間層を構成する物質より小さな屈折率の物質により分離されている構成となっている。

【０００９】

【作用】このように構成することにより、入射角度の大きいマイクロレンズへの光がマイクロレンズで光路を曲げられても、マイクロレンズ通過後の中間層の分離された境界で全反射し再度光路を変えられ、被写体からの光を効率よくフォトダイオードに導くことになり、感度の低下を防ぐことができる。

【００１０】

【実施例】以下、本発明の一実施例について図面を参照して説明する。図1は本発明の一実施例における固体撮像装置の断面図を示す。図1において、３１はシリコン基板、３２は光を信号電荷に変換するフォトダイオード、３３はフォトダイオード３２により変換された電荷を転送する転送部、３４はアルミ遮光膜、３５は転送部３３のゲート電極、３６は色分離フィルタ層形成のための平坦化層、３７は色分離フィルタ層、３８はマイクロレンズ形成のための平坦化層、３９はマイクロレンズであり、シリコン基板３１、フォトダイオード３２、転送部３３、アルミ遮光板３４、ゲート電極３５、マイクロレンズ３９は図1と同一のものである。また、平坦化層３６、３８、色分離フィルク３７より構成される中間層は隣りあうフォトダイオード３２の境界部分で分離層３０により分離され、この分離層３０は前記中間層の屈折率より十分小さい物質より構成される。

【００１１】図2は本発明の一実施例における固体撮像装置のフォトダイオード光入射の模式図を示す。被写体のある点からの光は光学レンズを通り、固体撮像装置の一点に集光される。フォトダイオードに着目した場合、図2のように光路４１から光路４２の範囲の光はマイクロレンズ１９により光路を曲げられ、フォトダイオードに入射される。さらに、光路４２から光路４３の光は、マイクロレンズ通過後、分離層３０と平坦化層３６、３８あるいは色分離フィルク層３７の境界に入射し、屈折率の差により全反射し、再度光路を修正され、フォトダイオード３２に入射することになる。したがって、光学レンズの絞り値が大きくなっても、光学レンズを通過し

た光を効率よくフォトダイオードに導くことができ、被写体の明るさに応じた感度を得ることができるようになる。

【００１２】なお、実施例では、中間層の分離層を屈折率の小さい物質で構成すると記述したが、固体撮像装置パッケージ内に封入される窒素ガスなどの気体でも同様の効果を得ることができる。

【００１３】

【発明の効果】以上のように本発明によれば、フォトダイオードおよびこのフォトダイオードに対向して配設されたマイクロレンズにはさまれる中間層を屈折率の小さな物質で分離し、マイクロレンズで光路を変えられた光を中間層の分離された境界で全反射させ、フォトダイオードに入射させることにより、低照度での感度低下を抑えることができ、その効果は絶大である。

【図面の簡単な説明】

【図1】本発明の一実施例の固体撮像装置の要部断面図

【図2】本発明の一実施例の固体撮像装置におけるフォトダイオードへの光入射の模式図

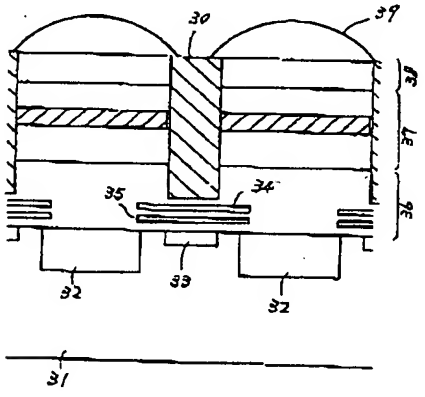
【図3】従来の固体撮像装置の要部断面図

【図4】従来の固体撮像装置におけるフォトダイオードへの光入射の模式図

【符号の説明】

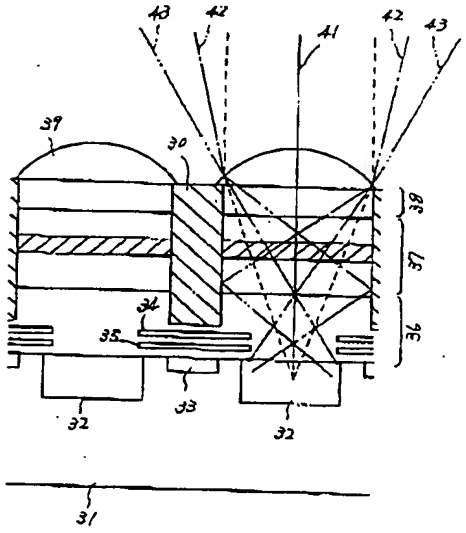
３０　分離層
３１　シリコン基板
３２　フォトダイオード
３３　転送部
３４　ゲート電極
３５　アルミ遮光膜
３６　平坦化層
３７　色分離フィルタ層
３８　平坦化層
３９　マイクロレンズ

【図1】



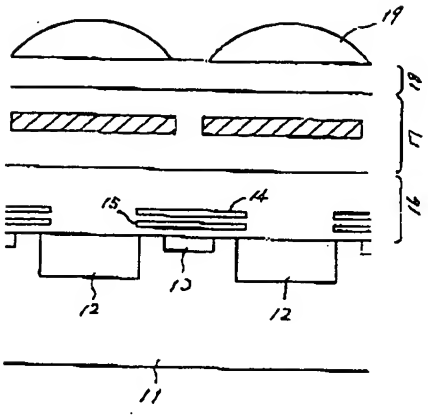
30 … 分離層　35 … アルミ遮光膜
31 … シリコン基板　36 … 平坦化層
32 … フォトダイオード　37 … 色分離フィルタ層
33 … 転送部　38 … 平坦化層
34 … ゲート電極　39 … マイクロレンズ

【図2】



41～43　光路

【図3】



【図4】